1,033,507

PATENT SPECIFICATION 1,033,507

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to a Leak-Tight Assembly of Two Metal Members.

I, CHARLES NAPPEE, a French Citizen, of 55, rue des Pavillons, Lille, Nord, France, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an assembly of two metal members providing a leak-tight joint to fluids under pressure, for example, an assembly of two automobile or industrial engineering type mechanical components.

More particularly, the invention is for use between members having, on a same plane, several orifices containing liquids or gases or both at high or low pressure and high or low temperature, as is the case between the cylinders and cylinder head of internal combustion engines, compressors, or like machines, and is also for use in flange connections, sumps, manifolds and the like.

As is well-known, before sealing gaskets became available, a seal between two metal members assembled together was obtained by seeking the highest possible degree of flatness on the surfaces to be applied together and by a powerful tightening of the assembling bolts. Perfect sealing was always difficult to ensure and never absolutely certain.

Recourse was then made to glands or gaskets composed of a plurality of superimposed sheets of ductile metal. Gaskets designed to withstand heat or corrosion were made with suitable materials. Nevertheless, to ensure a satisfactory leak-tight joint, it was imperative with such gaskets to develop powerful tightening forces and to provide means for locking the tightening members.

So-called metalloplastic gaskets were then developed. However, there are limitations on their use. Consisting of an assembly or agglomerate of metal and asbestos, they require that the screws or studs be tightened in a pre-determined order, using a torque wrench. These precautions explain the difficulties encountered in achieving not only a satisfactory leak-tight joint after fitting the gasket, but also durability in use. The gasket contour, which is determined by the number and shape of the cutouts, embodies therebetween irregular spaces which are differently stressed. The metal and the asbestos fibres will stand up to the action of fluids or heat, but the binding agent used to produce the asbestos sheeting is thinned down or carbonized over the restricted areas in contact with liquids, or subjected to high temperatures. Subsequent tightening, very often of an uncontrolled nature and designed to offset the reduced thickness of the asbestos sheet over these areas, causes permanent warping of the joint faces, due to the fact that the considerably stressed sound areas no longer have any elasticity. Machining of the joint faces and a new gasket then become indispensable to ensure a leak-tight joint once more. Metalloplastic gaskets are often too thick and have edges that are too thick to withstand high pressure. They cannot serve as acid-proof gaskets.

Recourse has also been made to all-metal gaskets, developed to a higher degree than those previously referred to. Certain of these gaskets have a thickness of between 1 and 2 mm and are made of steel or a suitable corrosion-proof material. Such gaskets are provided with a die-stamped ridge bordering the edges of the cutout parts to be sealed and of the contour of the gasket.

These relatively large upstanding ridge portions lack elasticity and produce corres-

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Price 75p

ponding deep imprints in the joint faces under the action of the tightening force and vibration. Machining is then indispensable subsequent to each dismantling operation.

A known alternative form of these gaskets consists in surrounding the cutouts to be sealed with a plurality of mutually parallel projections the triangular profile of which stands proud on each face of the metal gasket. Such projections or undulations, of relatively large depth, lack elasticity by reason of their shape. Possible warping subsequent to tightening can result in local deformations which can be the cause of incipient leaks. It will also be noted that in all these gaskets, the holes provided for the tightening screws or studs are devoid of undulations, whereas it is precisely at those points that the tightening force is greatest. The considerable centilever effect due to tightening can produce distortions that equal the initial thickness of the sheet-metal used for the gasket.

This invention provides for an assembly including a virtually indestructible gasket which can be made, as required, of a high-temperature resisting and corrosion-proof metal which, once fitted, possesses a reserve of elasticity ensuring a potential reaction comparable to that of compressed rubber. Vibrations, expansions and contractions are absorbed by this permanent elasticity.

The leak-tight assembly according to the present invention comprises, in addition to the two assembled members, a leak-proof gasket through the intermediary of which the opposed faces of the metal members bear against one another when assembled together, the gasket comprising a metal sheet having openings corresponding to those in the opposed faces of the metal members and having mutually parallel grooves forming somewhat elastic ridges which are compressed between the opposed faces of the members, some of which ridges systematically surround the openings for the tightening means and others of which extend around the opening or openings for the passage of fluids and partly surround the first ridges, to effect sealing where the maximum strain will occur in use, the parallel grooves acting as successive pressure reducers after the gasket has been fitted and tightened down and the ridges acting to balance the stresses caused by tightening down, especially adjacent the tightening means.

The gasket, which can be compounded of one or more thicknesses according to the surface condition of the members to be sealed together, is provided with multiple minute grooves which act like as many pressure reducers when the gasket is fitted in the assembly; that is to say, they form a series of cavities in which the pressure diminishes progressively. The profile of these grooves is carefully thinned down and assists deformation of the convex surfaces which, by a counter-swaging process, mate with the asperities on the joint faces. Intermediate grooves form by deformation of such convex surfaces in response to the tightening process, and equilibrate the stresses set up. However, the main features of this gasket reside in the arrangement of the grooves. They concentrically border all the holes provided for such tightening members as screws or studs and join with other grooves forming a closed loop enclosing the holes for the various fluids. The advantages of this arrangement are that the tightening force is entirely and uniformly distributed, around the region of such closed loop, which is the region of the gasket subjected to maximum strain in use.

In one embodiment of the invention, these gaskets are obtained by simultaneously cutting out and stamping a sheet of metal of suitable thickness and grade.

A gasket embodied in the assembly according to the present invention can be further improved in numerous ways.

By way of example, it is possible to combine the initial metal-to-metal contact, during the tightening process, with the contact of a ductile or plastic material at the end of the tightening process. This particular embodiment of the invention is particularly suitable for gasket assemblies calling for only low or moderate strength. It would be possible for instance to multiply the number of grooves impressed in a relatively soft and thin metal and to partly fill these grooves with a ductile or plastic material.

Three alternative methods of manufacture can be used, all of which involve initially cutting out the gasket profile.

In the first method, a swaging operation reproduces the grooves in very thin metal which is in the annealed or semi-cold-worked state.

These numerous grooves are then strengthened by hot-depositing thereon some ductile metal such as lead or tin or by cold-depositing thereon some plastic material such as a silicon, glycerophthalic or like varnish. The deposit is made in the liquid state, by immersion or projection, and the coating is spread in a thin layer over both gasket faces.

The fineness of the grooves makes the capillarity phenomenon very effective, and this phenomenon causes the liquid material to be drawn and concentrated into the hollows, thus forming ridges of exceptionally uniform, bulging and flexible section.

The undulating areas of the gasket, being greater than those of the flat joint faces, necessarily collect a greater volume of material, and the coating is distributed automatically, with great precision.

When such a gasket is tightened, it dimin-

ishes in thickness, the grooves are filled out, and the air contained therein escapes. The plastic material trapped in the grooves is pressed against the joint faces, penetrating or hugging the smallest asperities.

It will be appreciated that the flat joint faces remain unstressed after the tightening operation is complete and that they have the advantage of being protected against corrosion by the coating on the two faces and on the edges of the gasket bordering both the cut-out portions and the outer contour.

The second method consists in reproducing the grooves on either side of a blank by chemical etching or intaglio-engraving.

The groove contours are reproduced on both faces of the gasket by means of two positive-imprint traces designed to orientate the acid attack. These traces are offset by half a groove on one face with respect to the other in order to obtain non-opposed generating lines of contact.

The third method permits of obtaining grooves by the electro-formed deposit of metal, which produces threads or strips adhering to either side of a previously cut-out blank and preferably offset on one face with respect to the other, as indicated previously. When this is the case, deposit of metal takes place on those portions of the blank which had not previously been covered with a non-conductive coating.

The gaskets obtained thus are coated with ductile metal or plastic material, as in the first method described hereinbefore.

When the gasket is to have high strength, a fairly hard metal must be selected for the gasket, the grooves on the two faces being preferably opposed symmetrically. Such gaskets are not coated.

Two manufacturing processes can be employed, which can be classified as fourth and fifth methods, consisting in reproducing opposed grooves, respectively by chemical etching or electro-forming.

Constituted where necessary by treated and hence very hard metals, which in no way diminishes the efficiency of the chemical etching process, such gaskets, when tightened down powerfully, dig into the joint faces or flatten down completely.

In the specific case where the gaskets are obtained by electro-forming, they can be provided soft, hard, or very hard, depending on whether the filler metal is copper, nickel, or chrome, for instance.

The invention includes other features which will emerge from the detailed description given with reference to the accompanying drawing, which is by way of non-limitative example.

Referring to the drawing,

Figure 1 shows in plan view the upper part of the cylinder block of a single-cylinder engine the cylinder head of which is assumed to have been removed;

Figure 2 is a partial section taken through the line II—II, designed to illustrate a common defect of conventional gaskets;

Figure 3 is a similar section showing another type of gasket;

Figure 4 shows, in partial section through the line IV—IV, one embodiment of gasket for the assembly according to this invention;

Figure 5 is a similar section of an alternative embodiment of the gasket of Figure 4;

Figures 6 through 10 show in section on an enlarged scale the disposition and manner of operation of a gasket in the assembly according to this invention;

Figure 11 shows a gasket designed for insertion between the connecting flanges of two pipes;

Figure 12 shows in plan view the upper portion of the cylinder block of a twin-cylinder engine, illustrating on its left and right halves respectively two further embodiments of a gasket in an assembly according to the present invention;

Figures 13, 15, 17, 19 and 21 show in partial section through the line XIII—XIII various forms of construction of the gasket grooves; and

Figures 14, 16, 18, 20 and 22 are corresponding views of the gasket shape at the end of the tightening operation.

Figure 1 is divided into four sectors for the purposes of the detailed comparison given hereinafter.

The reference numeral 1 shows the bore of the cylinder containing the piston and bounding the combustion chamber; 2 the cooling water passageways provided in the gasket; 3 the hole for the lubricating oil under pressure fed to the rocker shaft; 4 the holes for the pushrods operating the valves, which holes also serve for the oil return flow; 5 the cylinder-head securing screws shown in section in their respective holes; 6 the cylinder wall; 7 the wall containing the cylinder and the cooling water; and 8 the wall which bounds the housing or casing containing the pushrods.

The shaded walls in the lower right-hand quarter of Figure 1 assume a section tc have been made beneath the fitting plane of the gasket, which section shows the manner of uniting with the threaded bosses into which screws 5 are screwed.

The dotted lines on the remainder of Figure 1 represent the various walls of the cylinder block.

Reference numeral 9 in the lower left-hand quarter of Figure 1 represents the cylinder block at the same level as the fitting plane of the gasket, which gasket is traversed by the holes 2, the function of which is to regularise the flow of cooling water to the cylinder head.

The upper half of Figure 1 shows two gaskets fitted between the two members to be assembled. The right hand gasket is an all-metal gasket of the known type referred to in the preamble to the present description. The double lines bound the ridges which surround the fluid-containing orifices and which follow the outer contour of the gasket. The enlarged-scale section II—II of Figure 2 reveals these ridges 10, showing the overhang at the level of tightening screws 5.

Figure 3 is a similar section through an alternative embodiment of this gasket, which is provided with a plurality of undulations but has the same defect. The thickness of the undulations in both these types of gasket cause distortion of the unsupported edges of the holes when tightening takes place, by reason of the overhang.

The upper left-hand quarter of Figure 1 shows a gasket according to the invention, while Figure 4 is a section thereof taken through IV—IV.

The parallel lines bounding the grooves will be noted, on Figure 1. These grooves are minute on the section of Figure 4 when compared with the undulations of the section of Figures 2 and 3. However, it is simple to make smaller or larger grooves as required.

Sets of grooves border the holes for the tightening screws 5, whilst further grooves partially surround such groove sets in forming a closed loop extending around the marginal portion of the gasket adjacent the periphery thereof, thereby to provide a leak-tight joint between the cylinder block and the cylinder head.

By a judicious distribution and disposition of the grooves it is possible to obtain ridges of perfect regularity.

Gaskets can be made which embody only these ridges, since they are sufficient to ensure leak-tightness. In the specific gasket illustrated, the flat portions 11 joining these ridges are useful for limiting the flows by means of calibrated holes such as the holes 2.

Figure 6 shows in greatly enlarged section the profile of the grooves prior to tightening. The stretching sustained by the metal when manufacturing the gasket by die-stamping produces the portions of reduced thickness shown at 12. These portions are useful to enable counter-swaging to take place as soon as tightening is initiated, as shown at 13 on Figure 7 and at the end of the tightening process in Figure 8.

The dot-dash lines in Figure 6 represent the case wherein a second superimposed gasket leaves between it and the first gasket grooves 14 which increase flexibility in cases where the surface condition of the joint faces is poor.

An alternative method of obtaining a thicker gasket consists in opposing two symmetrical gaskets disposed as in Figure 5.

Figure 9 shows on an enlarged scale this particular disposition prior to tightening, and Figure 10 shows it subsequent to the tightening ensuring leaktightness.

In no case is it possible to revert to the initial thickness of the sheet metal, the difference serving to absorb thermal fluctuations and vibration.

In Figures 6 and 9, the amount "h" by which the grooves are raised above the sheet metal is roughly equal to twice the thickness of the latter, while the width "l" of a groove is of the order of five times that thickness.

Figure 11 shows how the invention can be applied to a flange gasket for an exhaust manifold. The grooves fill out, as it were, the narrowest section to be sealed, located between the central orifice 15 and the tightening bolt holes 16. It will be noted that the section between the central orifice and the exterior is larger and comprises more grooves.

Patterns XI—XI and XIa—XIa are obtained by taking sections on the line XI—XI in the case of two constructions, one having a gasket with superimposed grooves in accordance with Figure 6 and the other having opposed grooves in accordance with Figure 9.

In designing a gasket which is part of an assembly in accordance with this invention, it is generally the smallest section that permits determination of the groove pitch, according to the pressure, tightening force, hardness and thickness of the metal involved, which metal must itself be carefully chosen to enable it to withstand possible thermal or chemical action by the fluids.

The left half of Figure 12 shows a gasket the cut profile of which virtually matches the contours of the joint faces on the cylinder-block and cylinder-head of a twin-cylinder engine.

This gasket includes grooves disposed as described precedingly, but the relatively soft and thin metal of which it is made is coated with a glycerophthalic varnish.

The quantity and distribution of the grooves is calculated in terms of the tightening force to prevent the gasket from marking the aluminium joint face.

A noteworthy feature is the flat portions containing the water passageway holes 2, the rocker shaft and oil return holes 4, and the rocker shaft lubricating oil hole 3.

The profile of this gasket is similar to that of the known metalloplastic gasket, but although this profile is necessary to ensure resistance of the asbestos, it is by no means indispensable for the gasket in the assembly according to this invention.

The right half of Figure 12 shows the preferred embodiment.

A system of grooves 10 surrounds the cylinder bore 1*a* as in the case of bore 1 for the left-hand gasket, but this system of grooves is supported only by narrow strips 16 directed towards the stud screw holes 5*a*.

The other groove clusters or systems 17 of the gasket located between the two members to be assembled like-wise join onto the stud holes. The spaces included between the latter and the immediately adjacent holes 2 are entirely covered with grooves. The holes 19 are completely uncovered.

Figures 13 through 22 are partial sections through XIII—XIII and are greatly enlarged in order to clearly illustrate the various alternative embodiments that can be resorted to for producing the gasket.

Figure 13 shows the gasket placed between the joint faces prior to tightening. The very small grooves obtained by swaging the metal assist the capillarity phenomenon, which in turn ensures a perfect spreading of the plastic coating 20 applied in the liquid state and shown by the heavily shaded areas.

Figure 14 shows the gasket of Figure 13 after it has been tightened down. The metal has deformed as indicated with reference to Figure 8 but has trapped the plastic material, which has been transformed into full ridges 21 ensuring perfect sealing.

The tightening process no longer involves only a metal-to-metal contact. Though very small, the grooves are much larger than the machining flaws on the joint faces, which are filled or completely coated by the plastic material.

Figure 15 shows offset grooves 22 obtained by chemically etching a metal blank.

This offsetting assists bending of the metal when the gasket is tightened down, whereby to trap and ensure thrusting of the plastic material 23, as shown in Figure 16.

Figure 17 illustrates a gasket with non-offset grooves 22, again obtained by chemical etching. As shown in Figure 18, this powerfully tightened gasket digs at 24 into the joint faces made of identical material, thereby dispensing with the need for a coating.

Figure 19 shows grooves 25 obtained by electro-formed reproduction of the upstanding strips 26 on the metal blank 27. As shown in Figure 20, these offset and coated grooves operate subsequent to tightening in the same way as the die-stamped or chemically etched grooves.

Lastly, Figure 21 shows non-offset grooves obtained by electro-forming. Tightening fully home flattens the filler metal 26, as shown in Figure 22, and ensures a leaktight joint due to close conformity to the various surface flaws on the joint faces of identical material.

WHAT I CLAIM IS:—

1. A leak-tight assembly of two metal members having at their adjacent faces corresponding openings providing for the passage of fluids and corresponding openings for accommodating screws or other tightening means, such assembly comprising, in addition to the two assembled members, a leak-proof gasket through the intermediary of which the opposed faces of the metal members bear against one another when assembled together, the gasket comprising a metal sheet having openings corresponding to those in the opposed faces of the metal members and having mutually parallel grooves forming somewhat elastic ridges which are compressed between the opposed faces of the members, some of which ridges systematically surround the openings for the tightening means and others of which extend around the opening or openings for the passage of fluids and partly surround the first ridges, to effect sealing where the maximum strain will occur in use, the parallel grooves acting as successive pressure reducers after the gasket has been fitted and tightened down and the ridges acting to balance the stresses caused by tightening down, especially adjacent the tightening means.

2. An assembly according to claim 1, including a plurality of elemental superimposed gaskets, the respective sets of grooves of which are superimposed upon one another in such manner that the convex portions of some engage into the concave portions of the others.

3. An assembly according to claim 1, including a plurality of superimposed elemental gaskets which are designed so that the grooves thereof are symmetrically disposed with respect to the plane passing between any two adjacent elemental gasket faces.

4. A gasket according to any preceding claim, wherein the grooves are formed in the gasket or in each elemental gasket by die-stamping a sheet-metal blank.

5. An assembly according to any one of claims 1 to 3, wherein the grooves are formed in the gasket or each elemental gasket by hollowing out a sheet-metal element by a chemical etching process that leaves upstanding ridges thereon.

6. An assembly according to any one of claims 1 to 3, wherein the grooves are formed in the gasket or each elemental gasket between upstanding strips deposited on a sheet-metal element by electro-forming.

7. An assembly according to any preceding claim, wherein the grooves, which are preferably offset on one face of the sheet-metal gasket or each elemental gasket with respect to the other face, are at least partly filled with a ductile metal or with a soft or plastic material which forms continuous layers in said grooves and which, after the gasket has been tightened, absorbs all asper-

ities on the adjacent faces of the members to be sealed together.

8. An assembly according to claims 5 or 6, wherein the ridges or strips, which are preferably provided symmetrically on each side of the sheet metal gasket or elemental gasket, are adapted to impress themselves into the joint faces of the elements to be sealed together, for which purpose such ridges or strips are made of a fairly hard metal.

9. An assembly according to claims 5 or 6, wherein the ridges or strips, which are preferably provided symmetrically on each side of the sheet-metal gasket or elemental gasket, are adapted to become crushed when the gasket is tightened down, for which purpose such ridges or strips are made of a metal softer than that of the adjacent faces of the members to be sealed together.

10. A leak-tight assembly of two metal members having a gasket between them, substantially as herein described with reference to Figure 1 and Figures 4 to 22 of the accompanying drawings.

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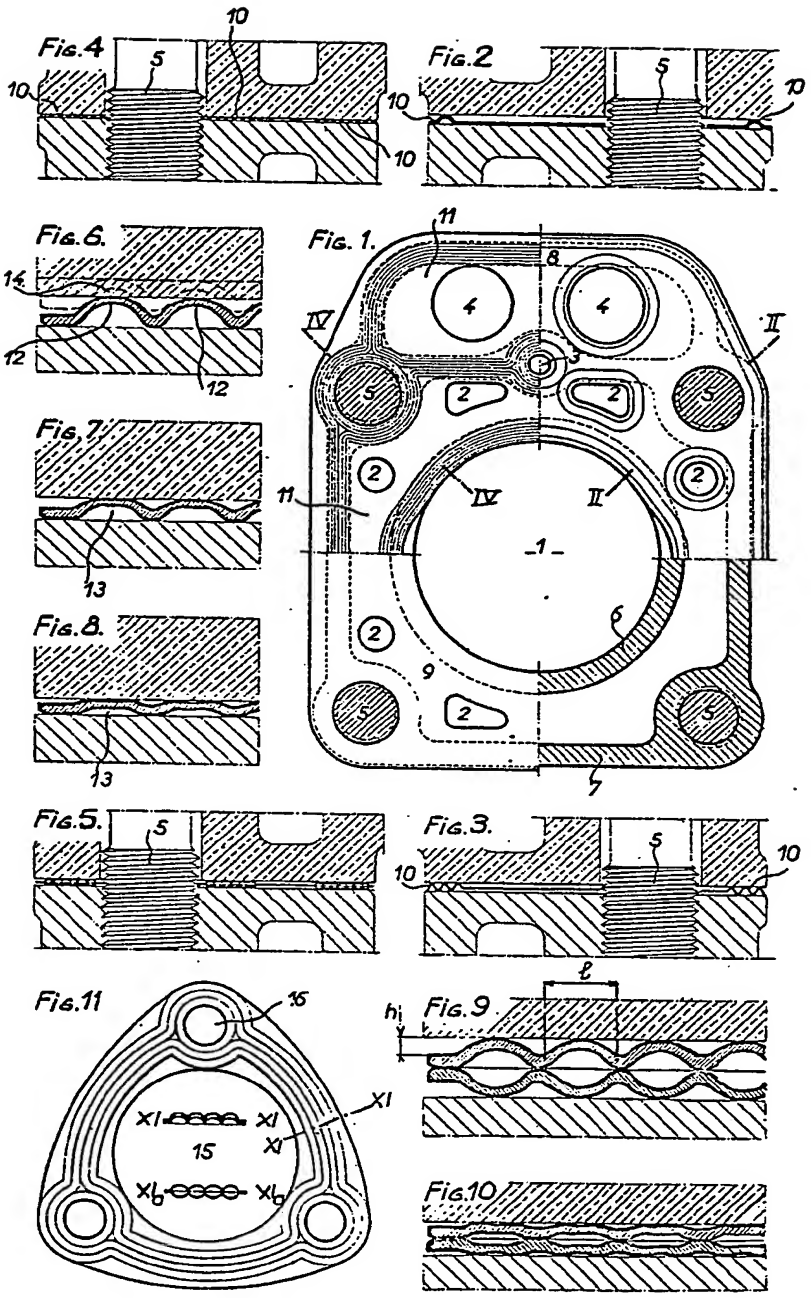
Fig.4
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Fig.2
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Fig.6.
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Fig.1.
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Fig.7
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Fig.8.
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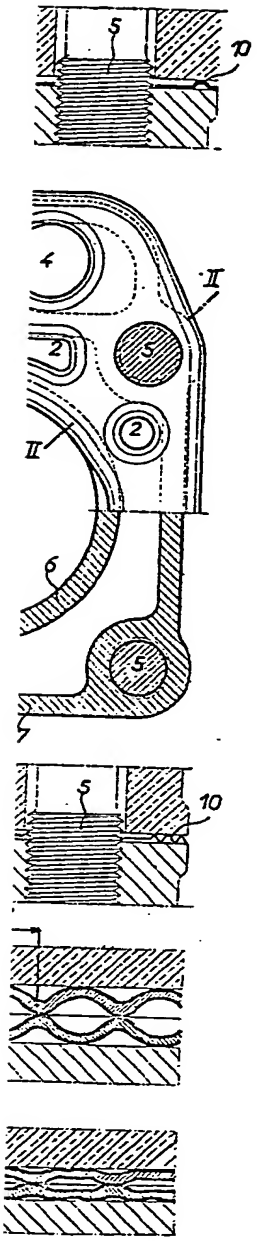


Fig.12

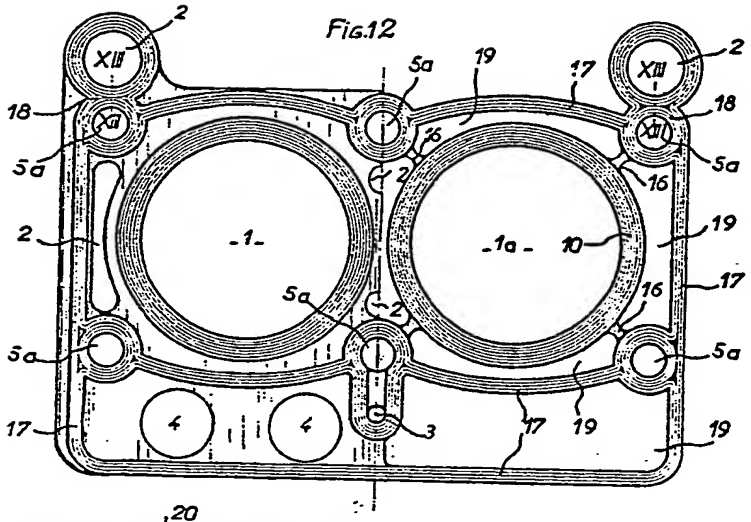


Fig13.

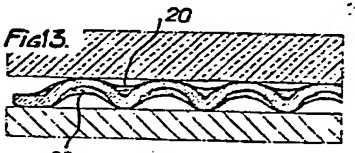
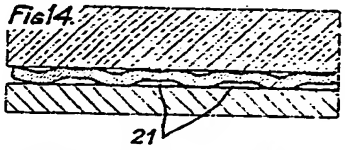


Fig14.



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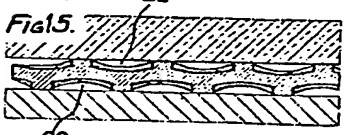


Fig16.

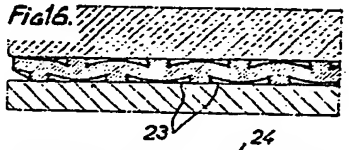


Fig17.

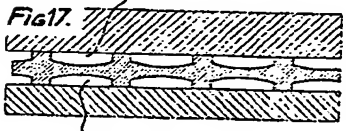


Fig18.

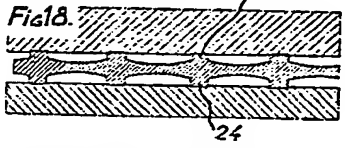


Fig19.

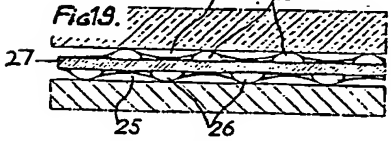


Fig20.

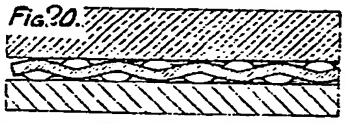


Fig21.

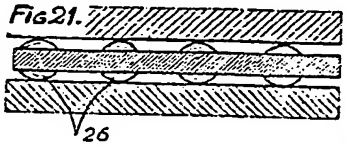
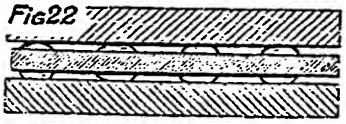


Fig22



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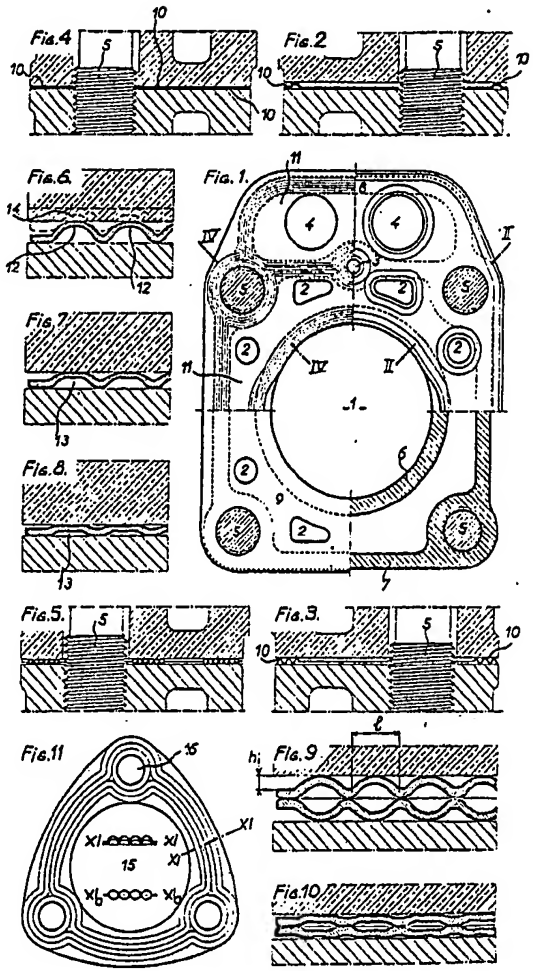

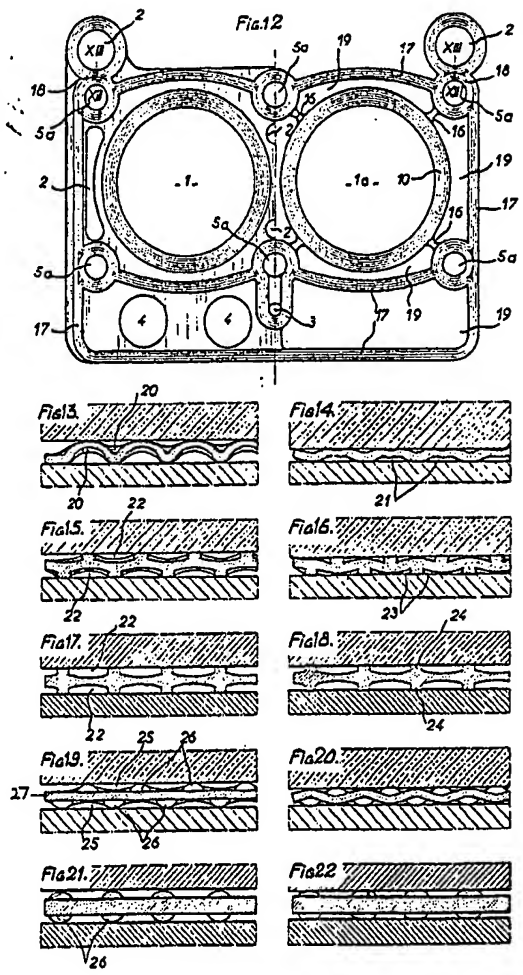

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MITTEILUNG

6

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Die folgenden Angaben des Anmelders wurden von der Recherchenabteilung genehmigt:

☐ Zusammenfassung ☒ Bezeichnung

☒ Die Zusammenfassung wurde von der Recherchenabteilung abgeändert und der endgültige Wortlaut ist dieser Mitteilung beigefügt.

Die folgende Abbildung wird mit der Zusammenfassung veröffentlicht: 1

RÜCKERSTATTUNG DER RECHERCHENGEBÜHR

Falls Artikel 10 der Gebührenordnung in Anwendung kommt, ergeht noch eine gesonderte Mitteilung der Eingangsstelle hinsichtlich der Rückerstattung der Recherchengebühr.

Europäisches Patentamt

EUROPÄISCHER RECHERCHENBERICHT

Nummer der Anmeldung
EP 04 00 2403

EINSCHLÄGIGE DOKUMENTE

Kategorie	Kennzeichnung des Dokuments mit Angabe, soweit erforderlich, der maßgeblichen Teile	Betrifft Anspruch	KLASSIFIKATION DER ANMELDUNG (Int.Cl.7)
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Der vorliegende Recherchenbericht wurde für alle Patentansprüche erstellt

Recherchenort	Abschlußdatum der Recherche	Prüfer
Den Haag	23. Juni 2004	Narminio, A

KATEGORIE DER GENANNTEN DOKUMENTE

X : von besonderer Bedeutung allein betrachtet
Y : von besonderer Bedeutung in Verbindung mit einer anderen Veröffentlichung derselben Kategorie
A : technologischer Hintergrund
O : nichtschriftliche Offenbarung
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T : der Erfindung zugrunde liegende Theorien oder Grundsätze
E : älteres Patentdokument, das jedoch erst am oder nach dem Anmeldedatum veröffentlicht worden ist
D : in der Anmeldung angeführtes Dokument
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ANHANG ZUM EUROPÄISCHEN RECHERCHENBERICHT ÜBER DIE EUROPÄISCHE PATENTANMELDUNG NR. EP 04 00 2403

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten europäischen Recherchenbericht angeführten Patentdokumente angegeben.
Die Angaben über die Familienmitglieder entsprechen dem Stand der Datei des Europäischen Patentamts am
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23-06-2004

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